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ENGINEERING 'ROUND ABOUT COLUMBUS

Inspected by
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IV. Where a Great Transformation Takes Place.

ASK any citizen what is the most important manufacturing plant in his town and you will get a variety of answers. In Schenectady he would say "General Electric of course." And so on, at every place put on the map by a particular industry, down to the home of the famous "57" varieties of pickles, where the citizens point with pride to the vinegar works—or at least they should.

The plant that all the rest of them depend on is liable to be overlooked. For the most important industry in any town is the waterworks.

It is a good idea to be duly impressed with the importance of water when one visits the Columbus Water Works, for the plant itself, though adequate and well displayed in the midst of the municipal golf course, is not especially imposing. It lacks the spectacular features of the storage dams. Part of it is underground. The laboratories themselves are red brick, low, and modest, and decently overgrown with ivy; the settling tanks make no mark on the skyline; and the pumping station looks like an electric plant—which, by the way, in its perfect fitness of appearance to the job to be done is generally a successful structure, architecturally.

In this group of buildings, winter and summer, in flood and drought, a water supply of uniform purity and quality is prepared and pumped to Columbus consumers. The year around average is thirty million gallons a day. For a few hours on some days, when everyone is trying to sprinkle, the pumping is at the rate of seventy million gallons.

The water in the river may be almost clear in drought, coffee-colored in flood. Regardless of the changes in the raw material, every faucet in the city is always the same—a sparkling fountain.

There might be an advantage in having conduits from O'Shaughnessey Dam and Griggs Dam directly to the plant, but it wouldn't be worth the cost. Water that pours over or is let through the dams finds its way on down the river bed, trickling over riffles, idling in pools, until it comes to the low diversion dam at the water works. Here some of it is pumped up, through huge pipes and screens, for the treatment that will change it from the raw state to the accepted standard of purity and excellence.

Those screens are important. When the river is full of leaves and other debris they are attended night and day. Despite this vigilance, we were told, a sizable piece of broomstick once got through and stopped one of the pumps.

Arrived at the treatment plant, the water is dosed with chemicals which, contrary to what one might expect and many fear, makes the finished product more free from "dope" than it is in the natural state. A few simple chemical reactions will make that clear.

For instance, there's lime hardness, calcium acid carbonate. When lime is added the equation is:

$$Ca\ (HCO_3)_2 + Ca(OH)_2 = 2CaCO_3 + 2H_2O$$

and the $CaCo_3$, being ordinary limestone, settles to the bottom. Magnesium hardness is dealt with in a similar manner. With the addition of lime the reaction is:

$$Mg(HCO_3)_2 + 2Ca(OH)_2 = Mg(OH)_2 + 2CaCO_3 + 2H_2O$$

and the $Mg(OH)_2$ and $CaCO_3$ precipitate. The first precipitate, incidentally, has the common name, "milk of magnesia."

So much for hardness. There's another impurity in the water, a great deal of it some of the time. That impurity is mud. To get rid of the mud another chemical—alum—is added to the water. Alum is well-known for being a rival in puckeriness of the green persimmon, but it is remarkable for another property; in water it collects in little curds. This curd or floc, reinforced with the precipitate from the lime, ensnares the particles of mud, bacteria, and other debris, and settles with them to the bottom of the big tanks.

Before the water leaves the settling basins there's still another chemical step. There might be too much lime in the water; in fact it's usually overdosed. So carbon dioxide gas, CO_2, made by burning coke, is bubbled through, and any excess lime becomes limestone and straightway settles to the bottom in accordance with the equation:

$$Ca(OH)_2 + CO_2 = CaCO_3 + H_2O$$

This settling is better far at the plant than in the pipes or the tea kettle.

V. Filtration and Chlorination.

The water now is pretty pure, but a bit cloudy, not the sparkling kind that comes from the faucets. It must be strained through filters.

The filters are arranged along a lengthy corridor, with control meters at each one, shaped, peculiarly, like table radio sets. They are called "rapid sand filters," the rapid referring to the filters and not to the sand, for until they get clogged, the water goes through them at a pretty fast rate. Each filter is about 1000 square feet in area and has a capacity of 3,000,000 gallons per day.

Filters clog with the bits of floc in the water. When a filter has got so loaded with scum that its efficiency is below par, it is washed by running pure water from a tank backward through it.

After filtering, the water is clear, and ordinarily pure, much freer from bacteria than most other things around us. But the water works engineers take no chances; they let an almost infinitessimal quantity of chlorine gas from a cylinder bubble through the liquid. It's much too small an amount to taste, one part in four or five million. But it safeguards us from tiny organisms that might be harmful.

Purified, filtered, and chlorinated, the water goes into the clearwell—appropriately named—to be pumped from there into the network of pipes that covers the city.

VI. The Heart of the System.

And now we come to the most important phase of the water works—pumping. In rebuttal to any objections to that statement the position we take is that any water is better than none at all. Without pumping equipment the world's best water would stand unused.

The proportions of the job done by the pumps cannot be fully appreciated by a mere statement of figures. Thirty million gallons (or thirty million anything) is a large number. But it seems even larger when our hasty slide-rule manipulations tell us that this is equivalent to a block one hundred feet on a side and four hundred feet high. If squeezed together a little more, to occupy a base seventy-five feet on a side, this imaginary column of water would tower well above the A. I. U. Building. To force this volume of liquid through miles and miles of piping is a Herculean job, indeed.

The visit to the engine room is, perhaps, the most thrilling part of the trip. You get that pigmy feeling of insignificance as you stand alongside one of the throbbing giants, three stories high.

There are three throbbing giants, triple expansion Corliss engines. The pistons move up and down moderately fast but with the sure deliberation of irresistible force. The flywheels revolve sedately. What happens to the water may well be imagined; when the cylinders of the pumps are filled, down come the pistons, relentlessly, and under heavy pressure the water makes its escape into the pipes. Precious little of it slides back along the cylinder walls.

That most famous and flexible pump in the world, the human heart, sends with each contraction a wave of living fluid through the arteries, pulsating first in the great vessels, branching into the smaller ones, and finally, its movement smoothed into regular flow, reaching the "customers," the individual cells. The city water system is similar. Corresponding to the arteries are the mains, then the smaller pipes, and finally the service lines, the whole layout, with the varying demand upon it—it would be interesting to know just how many people have the impulse to take a shower at any particular moment—smoothing out irregularities to make the more or less steady stream through the circulatory system of a great city.

To be sure, there are peak loads. On hot summer evenings every citizen is sprinkling—or so it seems. Monday mornings busy housewives tax the pressure as they start the family wash.

And there are low spots, too. The time between midnight and four or five o'clock is usually as near a rest period as you will find in the water works; not so many are drinking water or taking shower baths, some of the factories are down, and things are generally at a low ebb. But there is always a flow—taps forgotten, bath tubs running over, someone filling an automobile radiator, and most persistent of all, leaks at defective joints. Leaks cost money, and the cities are always on the lookout for them.

And suppose there is a great fire. Then there will be activity at the pumping station, for the customers as well as the firemen must be supplied. The ups and downs of water consumption make a fascinating study. They give a clue to the lives and habits of the people of a city. The waterworks must be able to take care of the whims of all the citizens.

Those ups and downs make a great difference at the waterworks pumping station. Pumps are not so flexible as the human heart. Suppose one of those giants is taking care of the minimum demand, in the early morning. People begin to waken, to take showers. The pump does its best but the pressure falls, so another giant must be cut in. This makes more capacity than is needed, yet.

This lack of flexibility cuts down the efficiency so dear to an engineer's heart. There is a way out, and the Columbus waterworks engineers have been taking it. At selected spots over the city they have built towers into which water can be pumped when there is excess capacity and drawn upon when the amateur gardeners begin to sprinkle.

Another device to keep pressure uniform is the booster station where auxiliary pumps give the lagging stream another impulse on its way to the consumer.

VII. The Modern Tendency — More Power in Smaller Packages.

Those giant Corliss engines with their pumps are the show pieces of the Columbus waterworks. A man can develop a real affection for their shiny brass rods, the sure uniformity of their reciprocating motion, and their friendly spirit. But they are not modern. They are still serviceable and efficient, but not the kind engineers would buy today if they were installing pumps, for this is the day of the turbine, sleek, compact machines, pumping away in their smug efficiency like purring tabby cats.

So efficient and so compact are the turbines with their centrifugal pumps that two of them will send out as much water as the three Corliss giants and occupy only a fraction of the space. One has to admire their efficiency, but just the same it's hard to be as fond of them as of the big friendly reciprocating engines.

For one thing, the parts of a reciprocating engine are out in the open. You can see what they do. The turbines just hum. Such complacent secrecy is bound to arouse a certain amount of suspicion in human hearts.

Of course engines and pumps, whether reciprocating or centrifugal, are only a part of the waterworks power house. There are so many auxiliaries. Boilers first (it's rather unfair to call them auxiliaries, for they supply the steam that makes the wheels go 'round) devouring coal from mechanical stokers, giving off heat—though that is energy and what is radiated should be as small as possible—and casting the refuse into the ash pit. Generators of electricity used at the plant. Pumps here and there, gages, switches, industrial railroad track for hauling ashes, boiler water softeners. In all, a maze of machinery, balanced for what it is to do, assembled with one purpose—to deliver pure water to the people of Columbus.

And of course, the human element, the men who throw the switches and read the gages, though here, as in any power plant, the men seem so few in number compared with the amount of machinery.

We have gone a long way toward developing automatic servants, machines that do it all.

But we shall never—so it seems—go all the way. The men are few in number, but they are important, for they furnish the intelligence that fires the whole undertaking.

Among them we met Bill, who tends the engines with loving care. He seems to feel for his charges, thinking of the strains imposed upon them, seeing to it that they are properly oiled and rubbed down and made presentable for visitors. He knows that nothing is more efficient and makes a more favorable impression than contented engines.

"Where did you learn to look after machinery?" we asked.

Bill grinned. His English had an accent.

"In the German Navy," he said, "I was an apprentice seaman, and later engineer on a destroyer. I was on a cruiser at the battle of Jutland."

"Were you at Scapa Flow?" we inquired. "How did the Germans manage that trick of scuttling the fleet that was to be surrendered?"

"I wasn't there," said Bill, "I was on land. But it was easy. The Germans were determined not to surrender those ships, and so the plot was agreed upon by signals. Nothing could stop them. It was agreed that at a certain time the sea cocks should be opened and the crews should take to the boats. And that's what happened."

And so we left the waterworks to inspect other plants in Columbus. We'll tell you about some of them in the next *Engineer*.